

From: John Edwards
To: [BAYUK Dana](#)
Cc: [Ben Hung](#); [Scott Coffey](#); [LARSEN Henning](#); [Jen Mott](#); [Mike Riley](#); [Lance Peterson \(PetersonLE@cdmsmith.com\)](#); [Sheldrake, Sean](#); [John Edwards](#); [Patty Dost](#); [Bob Wyatt](#); [John Renda](#); [Mike Gefell](#); [Miao Zhang](#); [Binglei Gong](#)
Subject: RE: NW Natural - Call on September 29 RE: Evaluation of Transducer Calibration Data
Date: Monday, November 13, 2017 1:30:09 PM
Attachments: [DEQ TransducerCalibration_11082017_Slides 3-8.pptx](#)
[DEQ Tables_deltaH_May2015toMay2016data_0.05ft_1113.pdf](#)
[DEQ Tables_deltaH_20162017_0.05ft_1113.pdf](#)

Hello Dana. Thanks for sending us DEQ's revised analysis.

Since receiving DEQ's direction to use a performance criterion of +/- 0.10 ft, Anchor QEA has continued to evaluate the suitability of the previously approved criterion of +/- 0.05 ft. To do this we have assessed the empirical head difference data from 2 years of HC&C system operation based on transducer and manual water level measurements. This evaluation uses an analysis methodology that is technically superior to the one previously used by Anchor QEA. The attached PowerPoint file contains six slides; including technical definitions of the factors used in the analysis, and five water level scenario diagrams that illustrate how the factors are derived from the water level data. The two attached PDFs contain the spreadsheets of our analysis of the 2015/16 and 2016/17 water level data using the factors and methodologies illustrated in the five water level scenario diagrams. You will see that the data illustrated in the five water level scenario diagrams are identified using color codes in the 2016/17 PDF spreadsheets.

The key finding from this analysis of the 2015 through 2017 data is that the former criterion of +/- 0.05 ft is more than sufficient and actually carries a conservative safety factor.

We request that DEQ review the attached information. Please feel free to call Miao Zhang, Mike Gefell, or me with questions during your review. Once DEQ has finished the review, please let us know so that we can schedule a face-to-face meeting to discuss our analysis and findings.

Thanks very much for your consideration.

John

From: BAYUK Dana [mailto:Dana.BAYUK@state.or.us]
Sent: Thursday, November 9, 2017 6:08 PM
To: Miao Zhang <mzhang@anchorqea.com>; Mike Gefell <mgefell@anchorqea.com>
Cc: Ben Hung <bhung@anchorqea.com>; 'Scott Coffey (coffeyse@cdmsmith.com)' <coffeyse@cdmsmith.com>; LARSEN Henning <Henning.LARSEN@state.or.us>; John Edwards <jedwards@anchorqea.com>; Jen Mott <jmott@anchorqea.com>; Mike Riley <mriley@anchorqea.com>; Lance Peterson (PetersonLE@cdmsmith.com) <PetersonLE@cdmsmith.com>; Sean Sheldrake <sheldrake.sean@epa.gov>
Subject: RE: NW Natural - Call on September 29 RE: Evaluation of Transducer Calibration Data

Good afternoon.

This e-mail follows up our conference call on September 29, 2017 to discuss DEQ's evaluation of water level measurements made manually and by transducer. DEQ e-mailed the evaluation on November 23, 2016. During the call we discussed DEQ's use of the AVEDEV function in the analysis of water level measurements and concluded the function did not meet the intent of DEQ's analysis.

Consistent with our discussions on the 9/29 call, DEQ revised the evaluation to use the average of the absolute difference between water level measurements made manually and by transducer. The results of DEQ's revised analysis is attached. Please note that revising the spreadsheet did not alter the HC&C system performance criterion. The criterion remains ± 0.1 -feet.

Henning and I appreciate your feedback on the water level measurements evaluation and hope your days have gone well.

Dana

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From: Miao Zhang [<mailto:mzhang@anchoragea.com>]
Sent: Tuesday, September 26, 2017 9:55 AM
To: BAYUK Dana; LARSEN Henning
Cc: John Edwards; Mike Gefell; Jen Mott; Ben Hung; Mike Riley
Subject: NW Natural - Call on September 29 RE: Evaluation of Transducer Calibration Data

Dana and Henning:

Thank you for agreeing to attend Friday's call. Our questions relate to how the performance criterion was estimated in the Excel spreadsheet that accompanied DEQ's November 23, 2016 email to Anchor QEA (included below for reference). A copy of DEQ's spreadsheet is attached. DEQ first used the AVEDEV function to calculate column R (Error Abs. Avg.) from columns B through N (error = difference between simultaneous transducer and manual measurements), and, for each well, summed AVEDEV for the well and tide gauges (column S). Finally, DEQ averaged the sum of AVEDEV between all the wells. The AVEDEV function calculates the average absolute deviation from the mean.

We do not fully understand the use of the AVEDEV function, because it is not consistent with how

column R is described in the spreadsheet and in DEQ's email. The title of column R (Error Abs. Avg.), note 2 associated with column S (sum of absolute error), and the reference to column S in the email (average sum of the total absolute error) appear to indicate that column R is intended to represent the average absolute error between all the months. However, the AVEDEV function does not calculate the magnitude of error. As a hypothetical example, if all the months have the same error (no matter how large or small), AVEDEV would report a value of zero because all the months have zero deviation from their mean. However, the error is clearly not zero. In other words, AVEDEV measures precision, not accuracy.

The other point that we'd like to discuss with you on Friday is that neither AVEDEV or average absolute error differentiates between neutral errors, conservative errors, and non-conservative errors. For example, if the error at a well and the river in a given month have the same magnitude and sign, the error in transducer-measured delta (between groundwater and river) would effectively be zero. As another example, if the error at the well causes the groundwater level to be biased high and the error at tide gauge causes the river level to be biased low, the error in transducer-measured delta (between groundwater and river) would be conservative. We think such scenarios should be considered in determining the performance criterion.

We look forward to a fruitful discussion on Friday.

Miao

Miao Zhang, P.E.

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From: BAYUK Dana [<mailto:dana.bayuk@state.or.us>]

Sent: Wednesday, November 23, 2016 2:30 PM

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Subject: RE: NW Natural, November 2015 through February 2016 H&C System Hydraulic Data - Evaluation of Transducer Drift and Calibration Data Report

Hello John.

DEQ reviewed the "Evaluation of Transducer Drift and Calibration Data, NW Natural Gasco Site" dated August 5, 2016 (Transducer Data Evaluation). The Transducer Data Evaluation presents NW Natural's evaluation of potential error associated with transducer data collected at monitoring wells and piezometers in the HC&C system monitoring network during the commissioning period (May 2015 through May 2016). Anchor QEA, LLC (Anchor) prepared the Transducer Data Evaluation for NW Natural.

The primary purpose of the Transducer Data Evaluation is to determine whether an adjustment should be made to the performance criterion being used to evaluate whether the HC&C system is achieving and maintaining hydraulic control and containment of groundwater in the Upper Alluvium WBZ, Lower Alluvium WBZ, and the Deep Lower Alluvium WBZ. The current performance criterion is to maintain water level elevations in monitoring wells and piezometers more than 0.05-feet below those of the Willamette River.

Differences between monthly manual water level measurements and transducer data form the basis of the evaluation. As indicated in the Transducer Data Evaluation, Anchor compiled and evaluated the differences by taking the arithmetic average of the monthly difference between manual measurements and transducer data for each location. Using this approach Anchor concludes the current criterion of 0.05-feet does not need adjustment.

DEQ further evaluated the water level data differences compiled by Anchor (see table attached). Based on our review and analysis of the data, DEQ does not approve the Transducer Data Evaluation. Our review and analysis determined the following:

- Conclusions regarding the error between manual measurements and transducer data should be based on the average sum of the total absolute error associated with groundwater and river stage water level measurements.
- Using the average sum of the total absolute error, the performance criterion for determining hydraulic control and containment should be increased from 0.05-feet to 0.1-feet (i.e., the water level elevations in each monitoring well and piezometer should be a minimum of 0.1-feet lower than the river to account for total absolute error).
- The highest priority measuring points for checking, confirming, and maintaining data accuracy include (in order of importance):
 - The two transducers in the river as they are the basis for HC&C system operations overall and measurement errors here are propagated throughout water level monitoring network;
 - All control wells given measurement errors influence the capacity of the HC&C system to achieve and/or maintain hydraulic control and containment in the vicinity of nearby extraction wells;
 - Monitoring well and piezometer locations that do not consistently meet the revised criterion

of 0.1-feet (see red-highlighted locations in the “Avg. Sum Error” column of the attachment) and/or installations of important to evaluating HC&C system performance (e.g., Deep Lower Alluvium WBZ monitoring wells, WS-8-59, WS-12-125).

- Monthly manual water level measurements are inadequate to monitor, evaluate, and/or rectify in a timely manner, errors between transducer and manual measurements. Consequently, for at least three consecutive months NW Natural should increase the frequency of manual measurements as follows:
 - Twice per week (semi-weekly) at both river stilling wells;
 - Weekly at all control wells; and
 - Every other week (bi-weekly) at all installations that do not consistently meet the performance criterion of 0.1-feet.

Regarding the remaining monitoring wells and piezometers in the network, NW Natural should continue measuring water levels monthly.

DEQ also recommends that the procedures being used to collect manual measurements be reviewed and modified to ensure data accuracy. Some of these best practice procedures include, but are not limited to:

- Synchronizing the field time when manual water level measurements are made with the transducer clock and/or PLC;
- Noting, recording, and using consistent water level meter sensitivity settings (many water level probes have this setting) when collecting the synoptic manual water level measurements; and
- Collecting and recording duplicate water level measurements at each sensor location to ensure measurements are consistent, or not being influenced by external factors.

The water level data collected according to this e-mail will be used to further evaluate differences between manual and transducer measurements and make adjustments to the water level monitoring program if appropriate. Furthermore, the revised protocols for measuring groundwater and river water levels should be fully incorporated into the HC&C system performance monitoring plan.

Please feel to contact me if you have questions or would like to arrange a date and time if you'd like to discuss this e-mail and the attachment.

Dana

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